Households credits and financial stability

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Households credits and financial stability: a theoretical model of financial intermediation

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Abstract: This paper develops a theoretical model of financial intermediation with three original features: first, consideration of all sectors within total outstanding credits, including households; second, the possibility of a non monotic relationship between prices and funding supply volumes in periods of high financial strains; last, the link between interbank credit rationing and other sectors funding rationing. The central bank conducts an unconventional type monetary policy. We show that the intermediation chain characteristics then determine the conditions of transmission of a shock on financing costs and the modalities for the resulting monetary policy.

JEL Classification: E58 (Central Banks and Their Policies) ; G01 (Financial Crises) ; G21 (Banks; Other Depository Institutions; Micro Finance Institutions; Mortgages; Foreclosures).

Keywords: Financial intermediation model, households credits, Central Banks.

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I would like to thank Peter Andrews, Morten Balling, Michel Boutillier, Franco Bruni, Emmanuel Carré, Jean-Bernard Châtelain, Jézabel Couppey-Soubeyran, Sylvester Eijffinger, Leonardo Gambacorta, Fabien Labondance, Catherine Lubochinsky, Donato Masciandaro, Catherine Refait-Alexandre, Peter Sinclair, and Laurent Weill for their advices and suggestions. I also thank for their comments on earlier versions of this paper participants in the 30th Symposium in Money, Banking and Finance (GDRE MBF, Poitiers, 27-28 juin 2013) and the 31st SUERF Colloquium & Baffi Finlawmetrics Conference "Money, Regulation and Growth: Financing New Growth in Europe" (Milan, 4-5 June 2014).

Introduction

For two decades, monetary policies have undergone profound changes, the latest being the widespread use of unconventional policies in advanced economies. The same can be said of characteristics of financing and intermediation systems. The first observation is the subject of many recent works. The second is less frequently considered, mainly in empirical studies referring to securitized credit and intermediation in the United States. The aim of this paper is to provide a theoretical model of complex financial intermediation with a central bank.

Despite the rise of a specific empirical literature, theoretical models of financial intermediation typically operate on the assumption of simple intermediation chains: firms have financing needs, which are met through credit corresponding to households financing capacities. The risks associated with this intermediation activity result from the necessary maturity transformation, i.e. "to transform illiquid assets into liquid liabilities" as in Diamond & Dybvig (1984). Recent theoretical models are still based on this assumption: for example, the interbank credit rationing model of Freixas & Jorge (2008) or the endogenous liquidation cost model of Stein (2012) describe a liquidity shock on bank balance sheets, resulting from a run of households on demand deposits, while loans are granted only to firms[1].

However, the features of intermediation in advanced economies are far from this scheme. First, the role of the arbitrage between bank deposits and direct holdings of Treasury securities does not seem decisive in the explanation of recent liquidity shocks on banks balance sheets (Strahan, 2012). Second, the firms financing needs are met to a large extent by intermediation in the broad sense (securities purchases by financial institutions), rather than credit. In both cases funding supply might be characterized by a complex relationship between prices and quantities in times of financial strains. Finally, households credits are an increasing part of both banks' balance sheets and total outstanding credits (Büyükkarabacak & Valev, 2010). This generates a specific double risk. On the one hand, defaults on households credits are sensitive to the output gap and interest rate risk (Benford & Nier 2007; Daglish, 2009). On the other hand, the massive occurrence of defaults is more frequent when banks do not hold credit portfolios (Berndt & Gupta, 2009; Maddaloni & Peydro, 2011; Purnanandam, 2011). This occurence generates simultaneous spread and liquidity shocks in the corresponding complex assets markets, and these shocks are transmitted in the short-term to interbank markets and then the whole financing systems (Krishnamurthy, 2010).

For these reasons, I propose a theoretical model of financial intermediation, defined by the importance of households credits within banks' balance sheets and total outstanding credits, and the degree of intermediation of corporate finance. The segments of the system are characterised by complex relationships between prices and volumes in times of financial strains, with the possibility that a persistent rationing in the interbank market increases the initial deterioration in funding conditions in other segments. The central bank conducts a monetary policy combining

[1] These mechanisms are also common in DSGE models explicitly taking into account intermediation activity: demand deposits and direct holding of riskless government securities are perfect substitutes (Curdia & Woodford, 2009 and 2010; Gertler & Karadi, 2011); business loans are financed by household deposits (Gertler & Karadi, 2011).

an augmented Taylor-type rule, liquidity injections and assets purchases. This results in two conclusions. First, the model highlights that, beyond the issue of the augmented Taylor rule, the importance given to the output gap affects financial stability. Second, the characteristics of intermediation determine the sharing of interest rate risk on credits between banks and borrowers, and thus the magnitude of shocks and modalities of the resulting monetary policy.

The paper is organized as follows: Section 1 focuses on recent developments of financial intermediation in advanced economies. The survey is the subject of Section 2. The model is presented in sections 3 (environment and actors) and 4 (effects of a shock on households credits defaults, depending on the characteristics of the intermediation system and preferences of the central bank).

1 Stylised facts of financial intermediation in advanced economies

The stylized facts of intermediation in advanced economies show that some of the usual hypotheses of theoretical models must be questioned. The first of these is that households credits are generally not taken into account (Figures 1 to 4[2]). With respect to the funding system as a whole (credit and securities markets), the subject of the relationship between prices and volumes in periods of financial strains appears to be critical (Figures 5 to 9). To conclude the section, we discuss the link between the various intermediation schemes and forms of the Taylor rule, in order to found the central bank rule in the model (Figure 10).

The first usual hypothesis which is problematic in the formalization of recent financial crises in advanced economies is the assimilation of banks credit portfolios to business credits. In fact, households credits represent 40% of banking intermediation activity in France and Spain and up to 80% in the United States, as shown in Figure 1. Furthermore, with the exception of Germany, where the weight of households credits is high compared to France or Spain, this share is growing.

In detail, Figures 2 (France), 3 (Germany) and 4 (United States) give an overview of the main characteristics of households credits and resulting vulnerabilities of bank assets. The first notable difference is the size of banks credits to non-financial agents, in comparison with banks assets: about one third in France, one half in Germany and 60% in the United States (Figures 2b, 3b and 4b). In addition, in France and Germany, the value of these credit portfolios increases less rapidly than that of securities portfolios. On the contrary, in the United States, the ratio is at best stable, indicating a similar growth in the value of credit portfolios and securities; and at worst increasing between 2003 and 2005, in contrast to France and Germany.

The second major finding is the comparison between total households credits and total outstanding credits to non-financial agents in banks balance sheet (Figures 2a, 3a, 4a): while the former is about one half of the latter in France and Germany, it is more than 160% in the

[2]All the figures are presented in the Appendix.

United States in 2007. Therefore, it is necessary to consider specifically households credits, in and outside of the traditional banking system, in formulating the intermediation scheme and central bank rule.

As regards the composition of households credits portfolios by term (Figures 2c, 3c, 4c) and destination (Figures 2d, 3d, 4d), there are again structural differences. In France and Germany, the share of short-term loans (with a maturity of less than 1 year) is very low when it is about one quarter in the United States. Moreover, long-term credits in France and Germany are characterised by a more diversified structure than in the United States, where they are almost exclusively composed of housing credits[3]. Finally, there are two distinct models. In the "European" model, households credits portfolios are *a priori* less sensitive to default risk (low proportion of short-term credits, diversified long-term credits). In the "American" model, they are more sensitive (relatively large proportion of short-term credits, almost no diversification of long-term credit portfolios in the long term). Following the assumption of Benford & Nier (2007) of a procyclicality of households credits defaults, it appears that the corresponding probability may be an endogenous variable in the model, function of whether they are held by the banking system or outside.

Turning to the financing system as a whole (credit and securities markets), the problem of the relationship between prices and quantities in times of financial strains appears to be crucial (Figures 5 à 9). Indeed, the shape of the funding supply function determines the effects of a positive shock on the cost of capital. Depending on the sign of the relationship, this shock may or not result in an excess funding demand. The experience of the current global crisis precisely leads to the conclusion that higher costs of capital are experienced simultaneously with a reduction of its availability in periods of high financial strains.

The data presented here concern the eurozone interbank market (2002-2012, Figure 5), credit markets (2003-2013, Figures 6 and 7), bonds (2003-2013, Figure 8) and equities markets (2005-2011, Figure 9). In all segments, in the first stage of the crisis (labeled as phase I in the graphs), there is indeed a negative relationship between prices and volumes: i.e. the simultaneous occurrence of a positive shock on the cost of capital and a reduction of its availability. This negative relationship between prices and volumes appears in the case of credit but also securities markets. This observation justifies that funding supply functions in the model are negatively related to prices in the context of high financial strains. The magnitude of the resulting output gap depends on the characteristics of financial intermediation and shapes of the funding supply function in the different credit and securities markets.

In credit and securities markets (Figures 6 à 9), the second stage of the crisis (labeled as stage II in the graphs) shows, after a period of rising prices and decreasing volumes, a period of falling prices in which volumes keep decreasing. Funding supply, therefore, decreases with the rise in prices in the first stage of the crisis (I), and keeps decreasing in the second stage (II) when prices fall. Our hypothesis, based on the theoretical model of interbank credit rationing of Freixas &

[3]Moreover, while in France and Germany variable rate loans accounted for 15% of new loans in 2007 (ECB, 2009), in the United States for the same year these loans represented 45% of total mortgage loans (New York Fed, 2010). This is not an unusually high value since the proportion exceeds 65% in 1994-1995.

Jorge (2008), is that there is a link between this uninterrupted decline in funding supply and the persistent dysfunction of the interbank market, which is obvious here (Figure 5, phase II). The existence of this connection between the persistence of an excess funding demand in the interbank market and the deterioration of funding conditions in the other segments of the system is a key hypothesis of the model.

In conclusion of the stylized facts, we establish a connection between the features of financial intermediation and a set of estimations of the Taylor rule which compares the ECB, FED and BOE and includes tests of the augmented[4] (with an indicator of financial conditions) setting (Castro, 2011). This approach (Figure 10) shows that the relevant form of the Taylor rule depends on the characteristics of financial intermediation. Thus, in the United States, the proportion of households credits in banking intermediation is particularly high. A low output gap thus meets a critical condition for financial stability, since unemployment and consequently households failures are directly related to this gap. Therefore, the central bank could indirectly achieve financial stability by using a non-augmented Taylor rule. Actually, the tests do not support the hypothesis of an augmented rule.

In the Eurozone, the proportion of households credits in banking intermediation is lower. Achieving financial stability requires to extend the range of the indicators that are taken into account beyond the simple Taylor rule. In practice, the tests validate the hypothesis of an augmented Taylor rule, with a financial conditions indicator. This setting is associated with a value of the output gap parameter which is significantly lower than in the general (i.e. non-augmented) settings. Finally, in the case of the UK, the proportion of households credits is relatively high, as in the United States. Achieving a low output gap thus partly creates the conditions for financial stability, and only one component of the financial conditions indicator which was tested (the credit spread) appears to be significant in monetary policy decisions. Combining these two sets of informations thus indicates a link between, on the one hand, the characteristics of financial intermediation in general and the proportion of households credits in particular; and on the other hand, the modalities of taking into account the financial stability objective by the three central banks.

Finally, the study of stylized facts brings up three key features. First, in times of high financial strains, all market segments can be characterized by higher prices simultaneously with a reduction in the availability of capital. In a second stage, the persistent dysfunction of the interbank market strengthens the funding rationing. Second, there are, schematically, two types of financial intermediation models concerning households credits. In the first model, these credits largely exceed total bank credits and are *a priori* more sensitive to default risk due to their composition. In the second model, their volume is significantly lower than total bank credits and their composition makes them less sensitive to default risk. Finally, in the first case, central banks would rather conduct a simple Taylor rule; and in the second case, an augmented Taylor rule including a financial conditions indicator.

[4]The general and augmented Taylor rule settings are discussed in detail in the survey.

2 Survey

Let us consider these three points. The first two concern the intermediation model, respectively with regards to banks assets, and the price-sensitivity of funding supply in the different segments of the financial system. The third point concerns the resulting monetary policy choices. Our purpose is to incorporate these mechanisms in a simple[5] theoretical model of financial intermediation with a central bank, in order to describe the management of a crisis generated by an unanticipated shock on households credits failures. To this end, we introduce a distinction for credit markets between households and firms from the perspective of borrowers, and between banks and non monetary financial institutions from the perspective of lenders. Thus, it is possible to take into account the roles of both households credits and shadow banking (Büyükkarabacak & Valev, 2010; Adrian & Shin, 2010).

As regards the trigger mechanism of the initial shock, the recent theoretical literature remains based on the principle of an arbitrage between bank deposits and direct holdings of Treasury securities as a source of liquidity shocks affecting the banking sector (Freixas & Jorge, 2009; Stein, 2012). Alternatively, the empirical literature (Adrian & Shin, 2010) discusses the existence of shocks to banks balance sheets which are actually linked to households behaviour but resulting from shocks on credit defaults, and not bank runs (Beck & al, 2008, Büyükkarabacak Valev & 2010). Theses defaults are specifically sensitive to the output gap and interest rate risk (Benford & Nier 2007; Daglish, 2009). Their magnitude also depends on the modalities of financial intermediation (Berndt & Gupta, 2009; Maddaloni & Peydro 2011 Purnanandam, 2011). In particular, securitized loans are subject to a higher default risk than other credits[6].

As regards the ultimate origin of the shock on households credits portfolios, formalisation must take into consideration both private agents behaviours, within the intermediation model, and monetary policy decisions. The literature relating to the crisis of 2007-2008 illustrates this dual causality. On the one hand, the modalities of financial intermediation have dramatically changed, due to "supply shocks" on monetary aggregates. These shocks are related to the behaviour of commercial banks (Goodhart, 2007) in the context of an increased liquidity resulting from international balance of payments imbalances. On the other hand, while these arguments tend to mitigate the responsibility of central banks in general and FED in particular, part of the recent empirical literature, based on the theory of the credit channel transmission of monetary policy (Bernanke & Gertler, 1995), calls into question changes in policy behaviour (e.g., with policy more focused on price stability, Boivin et al., 2010[7]). Thus, in our model, the shock on

[5]Our purpose is not to build a general equilibrium model, which are typically not adapted to our issues because they do not sufficiently address the issue of interbank risk premia (focusing on non-financial agents / banks relationships at the expense of the relationship between banks) and consequences of reaching the zero lower bound (Carré, 2011). We propose a simple model of financial intermediation, with a central bank conducting an unconventional monetary policy.

[6]Moreover, concerning liabilities of banks balance sheets, according to Purnanandam (2011), the link between securitization and credit defaults is enhanced when banks use little traditional deposit funding. This validates the principle of the theoretical model of Stein (2012), where the cost of liquidating assets is endogenous and positively related to the proportion of banks short term funding.

[7]The authors use a DSGE model taking into account "non-neoclassical" channel (i.e. credit channel) of monetary policy transmission. Their results suggest that monetary policy innovations and the effect of these changes on expectations, combined with changes in the regulatory environment, explain to a large extent that

households credits defaults is triggered by the decision of the central bank to raise the official interest rate, in accordance with the monetary policy rule. Then, the characteristics of financial intermediation determine the consequences of this shock, which will threaten the whole financial system if households and firms are already fragile, respectively as regards interest rate risk on outstanding loans and funding supply features.

The sequence of the model then presents the main stylized facts of the global crisis: the shock on variable rate loans leads to a deterioration of financing conditions in the corresponding complex securities market and, therefore, in the interbank market (Caruana & Kodres, 2008). Finally, the whole financing system is disrupted by a decrease in funding supply and increase in the cost of capital (Krishnamurthy 2010). This unusual configuration of funding supply is, however, fully in line with the principles of the credit (in case of a positive shock on the cost of capital, credit availability is reduced by the enhancement of informational asymmetries between lenders and borrowers; Bernanke & Gertler, 1995) and risk-taking (credit availability is reduced by the increasing risk aversion of lenders; Borio & Zhu, 2008; Gambacorta, 2009) channels of monetary policy transmission. Credit and securities markets are affected at various degrees (Cardarelli et al., 2011), taking into account that the procyclicality of credit may be positively related to the complexity of the financial system (Cornett et al. 2011). The magnitude of these dysfunctions determines the content and extent of fiscal and monetary policy measures, both directly, and via the resulting output gap (Gerali et al., 2010; Helbling and al., 2011; Hristov et al., 2012).

Regarding the central bank, beyond the issue of its responsibility in triggering the initial shock, the model must meet a specific constraint: the monetary policy rule has to describe decisions in both crises and non-crises times. A Taylor-type rule (Taylor, 1993) can achieve this objective. The precise formulation remains to be determined. The widespread use of this rule is mainly based on its simplicity, which is both its strength and limit. In addition to the questions of the proper formulations of inflation and output variables, and the values of the different central banks coefficients, two central issues are addressed in the literature. The first issue is the hypothesis of a nonlinear and/or asymmetrical rule (Cukierman & Muscatelli, 2008[8]; Castro, 2011). The second issue is the consideration of the objective of financial stability through an augmented rule including informational (Sturm & De Haan, 2011) or financial conditions indicators (Castro, 2011; Chadha et al, 2004. Hoffmann 2013). While the integration of the augmented Taylor rule in DSGE models is very gradual, the empirical literature usually show its relevance.

We retain the latter formulation, that is to say a Taylor type rule with a simple formulation of inflation and output gaps, augmented with a financial conditions indicator. This configuration of the Taylor rule is based on Ireland (2004), introducing the "money gap", i.e. the difference between the observed trend rate of growth of money supply and the value which would be consistent with the inflation target. Regarding the financial conditions indicator, there are two

monetary policy has a more muted effect on real activity and inflation in recent decades than before 1980.

[8]Using a specific theoretical model of asymmetrical central bank preferences depending on the monetary policy regime, Cukierman & Muscatelli (2008) test the nonlinearity of the Taylor rules conducted by the Bank of England and FED. Their results indicate that reaction functions and the asymmetry properties of the underlying loss functions are related to monetary policy regimes and major macroeconomic concerns of the moment. In addition, the asymmetry of central banks rules in favor of interest rate cuts may have in part created the conditions for the crisis.

possible settings of the augmented Taylor rule (CAE, 2011). The first possibility is to use volume indicators, such as credit indicators, which are well adapted to largely intermediated financial systems. The second possibility is to use asset prices or cost of capital indicators, such as credit spreads ("adjusted" Taylor rule; Curdia & Woodford, 2010), which are well adapted to disintermediated financial systems. Alternatively, the use of asset prices indicators is justified by the idea that the usual measure of inflation is not appropriate, primarily because it does not include their prices (Goodhart, 2007). In the model, the official interest rate is determined by a Taylor-type rule augmented with a price indicator of financial conditions, while volumes are also taken into account in the monetary policy rule. Since the initial shock is transmitted through the interbank market (Freixas & Jorge, 2008), the financial conditions indicator is the interbank spread, which is also an usual indicator of financial strains (Williams & Taylor 2009; Wu, 2008[9]) and is suitable for largely disintermediated and credit based systems as well.

In the formulation of monetary policy, the idea of a renewed interest of volumes and not only prices variables is quite extensively shared in the recent literature (eg, Adrian & Shin, 2010; Bordes & Clerc, 2010; Cukierman, 2013). The assumption of financial imperfections which would be limited to bank liquidity markets and would not affect stock or credit markets is now widely questioned (Bordes & Clerc, 2010), which justifies the end of the separation principle between monetary (associated with official interest rates) and financial stability policies (associated with credit policy). Moreover, in our model, the formalization of an unconventional monetary policy with its usual three instruments (interest rates, liquidity injections and assets purchases[10]; Bernanke et al., 2004)) cannot be limited to an augmented Taylor rule, which takes into consideration only one of these three instruments. For these two reasons, we include volume variables in the monetary policy rule, through the separate expression of the amounts of liquidity injections and assets purchases.

The model therefore includes the following elements: concerning the central bank, the augmented Taylor-type rule is accompanied with the conditions of a central bank intervention as regards the two other possible instruments of monetary policy (liquidity injections in the interbank market and assets purchases). The initial shock is triggered by an unanticipated increase in households credits defaults, which magnitude and consequences depend on the features of the intermediation model, i.e. the sharing out of households funding (alternatively held by banks or non monetary institutions) and firms funding (in the form of securities or credit).

[9]Wu (2008) shows that interbank spreads are sensitive to events in complex securities markets, directly through default rates on households mortgage loans and indirectly through banking sector CDS premia, which makes this indicator specially adapted to our problem.

[10]Mishkin (1996) already noted that « monetary [assets purchases] policy can be a potent force of reving economies which are undergoing deflation and have short-term interest rates near a floor of zero. Indeed, because of the lags inherent in fiscal policy and the political constraints on its use, expansionary monetary policy is the key policy action that is required to revive an economy experiencing deflation».

3 The model : agents and financial system

This section contains the description of the intermediation model and funding conditions associated with its different segments. It also contains the monetary policy rule and sequence of the model.

Funding of economic agents and market configuration

There are two types of assets in the model: credit, and securities. Credit markets correspond to $C1$ (interbank market) and $C2$ (credit to non financial agents). Primary securities markets correspond to $E0$ (government bonds), $E1$ (securities, issued by firms - NFC) and $E2$ (complex securities, issued by non monetary financial institutions - NMFI).

	E0 Government bonds	E1 Securities	E2 Complex securities	C1 Interbank credit	C2b Credit (banks)	C2nb Crédit (NMFI)
Government	X					
Firms (NFC)		X			X	
Households					X	X
Banks				X		
NMFI			X			

Table 1: Funding of economic agents

The funding of the agents in the model is described by the rows of Table 1. For the government, this funding is in the form of bonds. For households, it is in the form of loans, held either by banks (in proportion h_b of total banks credits portfolios), or NMFI. These loans are supposed to be fixed rates when they are held by banks ($C2_b$), and variable rates when they are held by NMFI ($C2_{nb}$) (see note 3 on page 4). The funding of firms is in the form of bank credit (in proportion $(1-h_b)$ of total banks credits portfolios) and securities. As regards financial sector, the (short-term) funding of banks is in the form of interbank credit, and the funding of NMFI in the form of complex securities.

The intermediation model is thus characterized by the share of households in bank loans(h_b), the share of households credits held by NMFI relative to total outstanding credits to non financial agents$\left(\frac{C2_{nb}}{C2_b+C2_{nb}}\right)$, and the share of securities funding of firms$\left(\frac{E_1}{(1-h_b)C2_b+E_1}\right)$.

Market conditions : credit markets

Each asset is characterized by market conditions described by the risk premium and excess funding demand. For a given asset, the risk premium π is defined as the difference between the nominal yield r and policy rate r_{CB}. The asset yield is thus as follows:

$$r = r_{CB} + \pi \tag{1}$$

In interbank ($C1$) and non financial agents credit markets ($C2$), excess funding demand CM_i is measured by the difference between credit demand DC_i and supply SC_i, which increases when credit interest rates rise. This result is obtained under the conditions that 1/ any increase in the credit interest rate deteriorates expected bank yields by increasing the probability of default on credit portfolios, and the aggregate supply function is then decreasing; and 2/ this function is also steeper than the demand function. Periods of low (high) interest rates are thus characterized by an excess credit supply (demand) (Figures 5 to 7). This specification is empirically justified by the observation that in times of financial strains funding costs increase simultaneously with the decline in outstanding volumes (Krishnamurthy, 2010). On a theoretical level, this observation is fully in line with the principles of the credit (Bernanke & Gertler, 1995) and risk-taking (Gambacorta, 2009) channels of monetary policy transmission[11]. Let CM_i denote the corresponding excess funding demand function:

$$CM_i = D_{Ci}\left(r_{Ci}\right) - S_{Ci}\left(r_{Ci}\right) \tag{2}$$

$$\frac{\partial D_{Ci}}{\partial r_{Ci}} < 0,\ \frac{\partial S_{Ci}}{\partial r_{Ci}} < 0,\ \left|\frac{\partial D_{Ci}}{\partial r_{Ci}}\right| < \left|\frac{\partial S_{Ci}}{\partial r_{Ci}}\right|$$

In the remainder of the paper, supply and demand functions in the interbank market are assumed to be linear:

$$S_{C1} = -c\, r_{C1} + d,\ c > 0,\ d > 0$$

$$D_{C1} = -a\, r_{C1} + b,\ c > a > 0,\ d > b > 0$$

$$CM_1 = (c - a)\, r_{C1} + (b - d) \tag{3}$$

Securities Markets

In securities markets, corresponding to indexes $E1$ (securities, firms) and $E2$ (complex securities, NMFI), the excess funding demand EM_i is measured by the difference between securities supply S_{Ei} and demand D_{Ei} for a given nominal yield r_{Ei}. As in credit markets, the demand function (funding supply) is assumed to be both decreasing and steeper than the supply function. Consequently, a shock on the cost of capital results in a positive excess funding demand, from an initial equilibrium situation (Figures 8 and 9). However, credit and securities markets are affected by excess funding demands of different magnitudes (Cardarelli & al., 2011).

$$EM_i = S_{Ei}\left(r_{Ei}\right) - D_{Ei}\left(r_{Ei}\right) \tag{4}$$

$$\frac{\partial D_{Ei}}{\partial r_{Ei}} < 0,\ \frac{\partial S_{Ei}}{\partial r_{Ei}} < 0,\ \left|\frac{\partial S_{Ei}}{\partial r_{Ei}}\right| < \left|\frac{\partial D_{Ei}}{\partial r_{Ei}}\right|$$

[11] Alternatively, this setting of funding supply could be seen as a generalization of the non-monotonic supply function of Stiglitz & Weiss. However, this function does not allow to determine the excess demand resulting from a shock on prices since the market equilibrium is not at the intersection of supply and demand curves.

In section 5 of the model, excess funding demand functions in credit and securities markets are supplemented by the consideration of two additional elements: first, the asymmetry in the impact of official interest rates decisions[12]; and second, the possibility of an increase in the excess funding demand, resulting from the persistent insufficient private funding in the interbank market.

Governement bonds market

The primary market for government bonds corresponds to index $E0$. Bonds supply S_{E0} depends on an exogenous component $\overline{S}$ (structural level of bonds supply, in the absence of a shock) and the amount of support measures to the sectors which would be affected by a shock on funding conditions. The shock affects the economy as a whole, but the different types of agents are all the more affected than their excess funding demand is important (Gerali et al. 2010; Helbling et al., 2011; Hristov et al. 2012). So fiscal measures aimed to support economic activity are allocated in proportion to excess funding demands:

$$S_{E0} = \overline{S} + \alpha \left(\sum_{i=1,2} CM_i + \sum_{i=1,2} EM_i \right), \ \alpha > 0$$

Consequently, when a shock arises, securities supply is increased by the amount of support measures to financial sector (in case of an excess funding demand in interbank and complex securities markets), households and firms (in case of an excess funding demand in credit and securities markets).

Government bonds supply D_{E0} takes a similar form. It depends positively on an exogenous component $\overline{D}$ (riskless part of assets portfolios, compliance with regulatory requirements), negatively on the current fiscal deficit S_{E0}, and positively on flight to quality effects generated by excess funding demands in other markets[13] . Depending on the sensitivity of economic agents to fiscal deficit, their risk aversion, and the resulting values of β and γ, the balance of the last two effects is then either positive (low β, high γ), or negative. Let D_{E0} denote the governement bonds supply function:

$$D_{E0} = \overline{D} - \beta\, S_{E0} + \gamma \left(\sum_{i=1,2} CM_i + \sum_{i=1,2} EM_i \right), \ \beta > 0, \ \gamma > 0$$

Replacing the supply function with its value gives:

$$D_{E0} = \left(\overline{D} - \beta \overline{S} \right) + \left(\gamma - \alpha \beta \right) \left(\sum_{i=1,2} CM_i + \sum_{i=1,2} EM_i \right)$$

Excess funding demand in the governement bonds markets is then the following:

$$S_{E0} - D_{E0} = (1+\beta)\, \overline{S} - \overline{D} + \left[\alpha\,(1+\beta) - \gamma \right] \left(\sum_{i=1,2} CM_i + \sum_{i=1,2} EM_i \right) \qquad (5)$$

[12] An increase in official interest rates is more largely passed on to the cost of capital than a decline. This is particularly visible in the comparison of changes in interest rates in househods and firms credit vs. interbank markets (Figures 5 to 7).

[13] As for fiscal policy in the supply function of government bonds, this effect is supposed to depend on the (unweighted) sum of all types of assets excess funding demands, since the model does not mainly focus on public debt. For a more general specification, see Bastidon et al. (2012).

For a given excess funding demand in other assets markets, the government bonds market, therefore, has an excess funding demand which is positively linked to α (fiscal policy activism) and β (sensitivity of economic agents to fiscal deficit), and negatively linked to γ (flight to quality effects).

Monetary policy rule

The monetary policy rule consists of three types of instruments: an augmented Taylor-type rule including a lower bound for the official interest rate, a liquidity injection function, and an assets purchases function. The official interest rate, thus, follows a Taylor-type rule (1993), augmented with a financial conditions indicator:

$$\begin{cases} r_{BCt} & = ct + \Pi + \mu_{\Pi}\left(\Pi - \Pi^{*}\right) + \mu_{y}\left(y - y^{*}\right) - \mu_{C1}\left(\pi_{C1} - \pi^{*}_{C1}\right) \\ & \qquad\qquad\qquad\qquad \text{with } \mu_{\Pi} > 0,\ \mu_{g} > 0,\ \mu_{C1} \geq 0 \\ & r_{BC} = r_{BCt} \text{ if } r_{BC_t} \geq \underline{r_{BC}} \\ & r_{BC} = \underline{r_{BC}} \ \text{ if } r_{BCt} < \underline{r_{BC}} \end{cases} \tag{6}$$

Since our purpose is to focus on the mechanism of central bank decision-making and not to assess monetary policy, the endogenous variable is the official (instrument) and not short-term interbank interest rate (target). This formulation also allows to isolate the endogenous interbank risk in the third term. So the official interest rate depends on a constant representing the neutral real interest rate, the inflation level Π, the inflation gap$(\Pi - \Pi*)$, the output gap $(y - y*)$, and the "risk premium gap" $(\pi_{C1} - \pi^{*}_{C1})$ [14] . It is worth noting that the coefficient associated with $(\pi_{C1} - \pi^{*}_{C1})$ can be zero. When the intermediation model is characterized by a significant weight of variable rates households credits, consideration of the output gap *de facto* affects financial stability. Moreover, the official interest rate can not be lower than its lower bound $\underline{r_{BC}}$, which is specific to each central bank.

The other two instruments of monetary policy concern excess funding demand in the different market segments. With the exception of credit to non financial agents, where the central bank usually can not conduct direct intervention, it has the possibility to meet a positive excess funding demand by liquidity injections (in the interbank market) and assets purchases (in securities markets). The preferences of the central bank are described below:

$$\begin{cases} CM_1 < \overline{CM_1}, & \overline{CM_1} = 0 \\ EM_0 < \overline{EM_0}, & \overline{EM_0} < 0 \\ EM_i < \overline{EM_i}, & \overline{EM_i} > 0,\ i = 1, 2 \end{cases}$$

For each market segment in which it has the possibility to conduct direct intervention, the central bank wants the excess funding demand to remain below a specific threshold. This threshold is, respectively, zero in the case of the interbank market, which should not be rationed; negative in the case of the government bonds market, which must be characterised by an excess demand; and positive for other securities markets. Consequently, in the interbank market, the amount

[14] The risk premium gap allows to introduce the concept of an optimal risk premium according to the central bank, given its knowledge of current interbank risk.

X of a possible liquidity injection corresponds to the amount of the excess demand of credit. Similarly, the possible amount Z_i of assets purchases corresponds to the difference between the excess funding demand and threshold of the central bank. Therefore, the monetary policy rule is as follows:

$$r_{BC} = \begin{cases} r_{BC} = r_{BCt} & \text{if } r_{BC_t} \geq \underline{r_{BC}} \\ r_{BC} = \underline{r_{BC}} & \text{if } r_{BCt} < \underline{r_{BC}} \\ \Delta r_{BCt} \neq 0 & \implies (\Delta r_{BCt})\,(\Delta r_{BCt+1}) \geq 0 \end{cases}$$

$$X = \begin{cases} CM_1 - \overline{CM_1} & \text{if } CM_{1\ t-1} > \overline{CM_1} \\ 0 & \text{otherwise} \end{cases}$$

$$Z_i = \begin{cases} EM_i - \overline{EM_i} & \text{if } r_{BC} = \underline{r_{BC}},\ EM_{i\ t-1} > \overline{EM_i},\ EM_{i\ t-2} > \overline{EM_i} \\ 0 & \text{otherwise} \qquad\qquad\qquad\qquad i = (0,2) \end{cases} \tag{7}$$

This can be expressed simply as follows. The official interest rate corresponds to the Taylor type rate if its determination leads to a higher value than the lower bound; and to this lower bound otherwise. Liquidity injections and assets purchases are only conducted when the excess funding demand exceeds the central bank threshold - in this case, they are conducted in order to reduce this level to the threshold. This occurs systematically at the next period in the case of the interbank market. By contrast, it takes place after two consecutive periods of excess funding demand in the case of securities markets, only if the policy interest rate is at the lower bound. Finally, as regards the official interest rate, the central bank cannot take two immediately consecutive decisions in opposite directions.

Sequence of the model

The sequence is composed of three periods. All the markets are originally in equilibrium, i.e. characterized by an excess funding demand equal to zero. In t_0 a positive monetary policy (official interest rate) shock happens. This results in an increase in the cost of variable rate loans contracted by households, a negative output gap, and thus an increase in defaults on these loans.

t_0 *Defaults shock*

MP shock > 0,
output gap < 0
→ increase in default rates / households variable rates credits

t_1 *Financial crisis, 1st stage*

→ MP: liquidity injections

t_2 *Financial crisis, 2nd stage*

→ second choc on NFA funding conditions
→ MP: liquidity injections, official interest rate lower bound, assets purchases

Table 2: Sequence of the model

The increase in defaults on variable rates credits in t_0 causes a risk premium and excess funding demand shock in the complex securities and, therefore, interbank markets. In t_1, if needed, the central bank injects the amount of liquidity corresponding to excess funding demand (in comparison to private interbank credit supply) in the interbank market. Because of the central role of the interbank market in the transmission of the shock, this injection is the first crisis management measure taken by the central bank.

In t_2, credit and securities markets undergo a second deterioration of their funding conditions, because of the persistence of an excess funding demand in comparison to private supply in the interbank market. The central bank continues liquidity injections, in order to compensate for the failure of private funding supply, and uses the other two instruments in its monetary policy rule: interest rate cuts, and if the lower bound is reached, possible assets purchases in securities markets.

4 The model: Defaults shock on households credits and crisis management by the central bank

This section contains the explanation of the relationship between interest rate risk-sharing and defaults on credit portfolios, and the description of the initial shock in the complex securities market, in t_0. The shock is transmitted to the interbank market, where the central bank conducts liquidity injections in t_1 and t_2. A possible intervention in securities markets takes place in t_2.

I*nterest rate risk-sharing and defaults on credit portfolios*

Consideration of an endogenous default rate of non-financial agents (i.e. households) is one of the fundamental assumptions of the model. This probability depends on two characteristics of the intermediation model: the proportion of interest rate risk borne by households (share of households variable rates credits in total outstanding households credits); and the disintermediation of corporate finance (respective shares of securities and credit), which determines the output gap and thus also affect the households repayment capacity.

Defaults on households credits are related to interest rate risk. We assume that the interest rate risk associated with credits held by banks is fully borne by banks (fixed rate loans), while the interest rate risk associated with credits held by NMFI is borne by households (variable rate loans). In this case, the fact that borrowers bear the entire interest rate risk leads to a positive link between interest rates variations and default rates. In the model, this risk is the first determinant of the default function of households on their variable rate loans.

Defaults on households credits are also related to the output gap. Regarding corporate finance, we assume that the double effect resulting from the enhancement of informational asymmetries and risk aversion of lenders reduces the availability of both credit and securities funding, at various degrees (e.g., Cardarelli et al., 2011). This mechanism is taken into account, in the model, with funding supply functions of different slopes. The reduced availability of funding resulting from a positive monetary policy shock is then the weighted sum (depending on the intermediation of corporate finance) of the respective excess funding demands in credit and securities markets. This results in a negative output gap (Gerali et al. 2010; Helbling et al., 2011; Hristov et al., 2012), which is the second determinant of the default function of households on their variable rate loans.

Initial shock in credit and complex assets markets (t_0)

Let λ_b and λ_{nb} denote default rates on credits, respectively held by banks and NMFI. In the model, for the sake of simplicity, λ_b is supposed to be constant and exogenous. By contrast λ_{nb} is endogenous and depends positively on official interest rates variations and the output gap (Benford & Nier, 2007 ; Daglish, 2009):

$$\lambda_b = Cte$$

$$\Delta\lambda_{nb} = \zeta\, \Delta r_{CB} + \eta\, \Delta y,\ \zeta, \eta > 0$$

This setting corresponds to a default rate on credits held by NMFI λ_{nb} which is always greater the default rate λ_b on credits held by banks[15] (Berndt & Gupta, 2009 ; Maddaloni & Peydro 2011, Purnanandam, 2011).

The shock is triggered by an increase in the official interest rate ($\Delta r_{CB} > 0$). Under the assumption that the output gap is proportional to the weighted sum of the variations in excess funding demands of firms in credit and securities markets[16], we obtain the following form. It is worth noting that interest rates have both a direct effect through the interest rate risk on households variable rate loans, and an indirect effect through the output gap:

$$\Delta\lambda_{nb} = \zeta\Delta r_{CB} + \eta\left[\frac{E1}{(1-h_b)\, C2_b + E_1}\ \frac{\partial EM_1}{\partial r_{CB}} + \frac{(1-h_b)\, C2_b}{(1-h_b)\, C2_b + E_1}\ \frac{\partial CM_1}{\partial r_{CB}}\right] \tag{8}$$

NMFI, which hold variable rates households credits, are funded by selling complex securities. In return, the remuneration of these securities depends on the interests flows on portfolios of variable rates credits. Therefore, the rise in the corresponding default rate λ_{nb} entails a rise in the risk premium π_{E2} in complex securities market, which is assumed to be equivalent:

$$\Delta\pi_{E2} = \Delta\lambda_{nb} \tag{9}$$

Considering the securities supply and demand functions (equation (4)), this results in a positive excess funding demand in the complex securities market.

[15]Since the initial value of the former is greater than the latter, which in practice is always the case.

[16]Since all the markets are assumed to be in equilibrium before the shock, any increase in the cost of capital, whether caused by an increase in the risk premium or official interest rate, generates a positive excess funding demand.

Transmission of the initial shock to the interbank market and liquidity injections(t_1)

The shock on funding conditions in the complex securities market is transmitted to the interbank market. This results in a simultaneous rise of the interbank risk premium and excess funding demand:

$$\begin{cases} \Delta\pi_{C1} > 0 \\ \Delta CM_1 > 0 \end{cases}$$

The variation of the interbank risk premium depends on the variation of the risk premium in the complex securities market at the origin of the shock (equations (8) and (9)), the size j of this market compared to total outstanding credits, and a random variable ϵ:

$$\Delta\pi_{C1} = \Delta\pi_{E2}\; j\,(1+\epsilon)$$

Which is equivalent to:

$$\Delta\pi_{C1} = \Delta\pi_{E2}\left(\frac{C2_{nb}}{C2_b + C2_{nb}}\right)(1+\epsilon) \tag{10}$$

$$= \left(\zeta\Delta r_{CB} + \eta\left[\frac{E1}{(1-h_b)\,C2_b + E_1}\,\frac{\partial EM_1}{\partial r_{CB}} + \frac{(1-h_b)\,C2_b}{(1-h_b)\,C2_b + E_1}\,\frac{\partial CM_1}{\partial r_{CB}}\right]\right)\left(\frac{C2_{nb}}{C2_b + C2_{nb}}\right)(1+\epsilon)$$

The total variation of the interbank interest rate is thus the following:

$$\Delta r_{C1} = \Delta r_{CB} + \Delta\pi_{C1}$$

$$\Delta r_{C1} = \Delta r_{CB} + \Delta\pi_{E2}\left(\frac{C2_{nb}}{C2_b + C2_{nb}}\right)(1+\epsilon) \tag{11}$$

Since the interbank lending market was originally in equilibrium, the excess funding demand (in comparison to private interbank credit supply) is described by the following equation:

$$CM_{1\,t1} = (c-a)\left[\Delta r_{BC} + \Delta\pi_{E2}\left(\frac{C2_{nb}}{C2_b + C2_{nb}}\right)(1+\epsilon)\right] \tag{12}$$

The central bank responds to this excess demand by injecting the corresponding amount of liquidity, according to its monetary policy rule (equation (7)), i.e. $X_{t1} = CM_{1\,t1}$. The monetary policy rule is specifying that the central bank cannot take two immediately consecutive interest rates decisions in opposite directions, so liquidity injections are the only available instrument in t_1. Excess funding demand in securities markets does not either generate an intervention, since the central bank can conduct assets purchases only after the second consecutive period of positive excess funding demand.

Interest rate lower bound and liquidity injections (t_2)

In t_2, the default rate on households variable rates credits (equation (8)) is assumed to be unchanged. This is the same for risk premia in complex securities (equation (9)) and interbank (equation (10)) markets. As regards monetary policy, an interest rate cut is possible, considering the persistent negative output gap and financial strains (represented by the interbank “risk premium gap”, equation (6)), since this decision is not immediately following the initial interest rate rise. The remainder of this section deals with the case where in t_2 the interest rate is taken to its lower bound $\underline{r_{BC}}$, in which the central bank is likely to conduct assets purchases in order to meet an excess funding demand in securities markets.

In practice, the interbank risk premium π_{C1} is unchanged, and the official interest rate is set at the lower bound. According to (11), the difference between the interbank interest rate and the initial (before the shock) equilibrium value r^*, can be written as follows:

$$\Delta r_{C1\,t1} + \Delta r_{C1\,t2} = \left(\underline{r_{BC}} - r^*\right) + \Delta\pi_{C1\,t1}$$

$$\Delta r_{C1\,t1} + \Delta r_{C1\,t2} = \left(\underline{r_{BC}} - r^*\right) + \Delta\pi_{E2}\left(\frac{C2_{nb}}{C2_b + C2_{nb}}\right)(1+\epsilon) \tag{13}$$

The excess funding demand (in comparison to private interbank credit supply) in the interbank market in t_2 is thus described by:

$$CM_{1\,t2} = (c-a)\left[\left(\underline{r_{BC}} - r^*\right) + \Delta\pi_{E2}\left(\frac{C2_{nb}}{C2_b + C2_{NB}}\right)(1+\epsilon)\right] \tag{14}$$

This excess demand, as in t_1, is met by a central bank liquidity injection of the same amount, that is $X_{t2} = CM1_{t2}$. In the other private sector asset markets (credit and securities), the excess funding demand is aggravated by the persistence of an insufficient interbank credit supply, according to the principle of the "rationing channel" of Freixas and Jorge (2009):

$$\begin{cases} \Delta CM_2 = \nu_{C2} CM_1 \\ \Delta EM_i = \nu_{Ei} CM_1 \quad i = 1,2 \end{cases}$$

Coefficients ν represent the correlation coefficients between excess funding demand in the interbank market, and the additional excess funding demand in each segment. Considering that decreases in official interest rates are passed on to interest rates on households and firms credits to a very limited extent in comparison with interbank markets (see note 12 on page 11), the latter are assumed to be unchanged compared to t_0 and t_1 for the sake of simplicity. Therefore, the excess funding demand corresponds to the sum of the value of periods t_0 and t_1, and the additional component described above, that is:

$$\begin{cases} CM_2 = \frac{\partial CM_2}{\partial r_{CB}} + \nu_{C2} CM_1 \\ \\ EM_i = \frac{\partial EM_i}{\partial r_{CB}} + \nu_{Ei} CM_1 \quad i = 1,2 \end{cases} \tag{15}$$

Crisis management and assets purchases (t_2)

In t_2, in addition to liquidity injections, the central bank conducts assets purchases in securities markets (government bonds and other securities), in order to reduce the persistent gap between funding supply and demand to its desired threshold. This occurs only in the case where the official interest rate is set at its lower bound (Mishkin, 1996). As regards government bonds, using (5) and (15), the central bank determines the necessary amount of assets purchases, in order to meet the excess demand threshold defined by its monetary policy rule (7). In the case of government bonds, the excess funding demand takes the following form:

$$S_{E0} - D_{E0} = (1+\beta)\overline{S} - \overline{D} + [\alpha(1+\beta) - \gamma]\left(\sum_{i=1,2} CM_i + \sum_{i=1,2} EM_i\right)$$

$$S_{E0} - D_{E0} = (1+\beta)\overline{S} - \overline{D} + [\alpha(1+\beta) - \gamma] \left[CM_1 + \left(\frac{\partial CM_2}{\partial r_{CB}} + \nu_{C2} CM_1\right) + \sum_{i=1,2}\left(\frac{\partial EM_i}{\partial r_{CB}} + \nu_{Ei} CM_1\right)\right] \tag{16}$$

If this difference is superior to the threshold level $\overline{EM_0}$, the central bank will conduct assets purchases of the corresponding amount, that is:

$$Z_0 = (S_{E0} - D_{E0}) - \overline{EM_0}$$

In the other (private sector) securities markets the same principle applies. If the excess funding supply, in comparison to private funding supply, is superior to the threshold level, the central bank purchases assets as long as this value is not reached. Using (14) and (15), we get:

$$Z_i = (S_{Ei} - D_{Ei}) - \overline{EM_i}, \ i = 1,2$$

$$= \frac{\partial EM_i}{\partial r_{CB}} + \nu_{Ei} CM_1 - \overline{EM_i}$$

$$Z_i = \frac{\partial EM_i}{\partial r_{CB}} + \nu_{Ei}(c-a)\left[\left(\underline{r_{BC}} - r^*\right) + \Delta\pi_{E2}\left(\frac{C2_{nb}}{C2_b + C2_{NB}}\right)(1+\epsilon)\right] - \overline{EM_i} \tag{17}$$

The decisions of the central bank in t_2, in accordance with its monetary policy rule (7), are thus the following:

$$\begin{cases} r_{BC\,t2} = \underline{r_{BC}} \\ X_{t2} = CM_{1\,t2} - \overline{CM_1} \\ Z_{0\,t2} = (1+\beta)\overline{S} - \overline{D} + [\alpha(1+\beta) - \gamma] \\ \quad \left[CM_1 + \left(\frac{\partial CM_2}{\partial r_{CB}} + \nu_{C2} CM_1\right) + \sum_{i=1,2}\left(\frac{\partial EM_i}{\partial r_{CB}} + \nu_{Ei} CM_1\right)\right] - \overline{EM_0} \\ Z_{i\,t2} = \left(\frac{\partial EM_i}{\partial r_{CB}} + \nu_{Ei} CM_1\right) - \overline{EM_i}, \ i = 1,2 \end{cases} \tag{18}$$

The values of $CM_{1\,t2}$ and $\Delta\pi_{E2}$ are respectively given by equations (12), and (8) and (9).

These results allow to identify the effects of the initial shock on households variable rate credit portfolios on excess interbank funding demand. These effects positively depend on the magnitude of the initial shock on official interest rates (both directly via the increased interbank interest rate, and indirectly via the increased default rate on households credits); the weighted sum of the deterioration of funding conditions of firms in credit and securities markets; the relative importance of households variable rate credit portfolios within total outstanding credits; the difference between the lower bound official interest rate and the initial interbank interest rate; and finally, the difference in slopes of the funding supply and demand functions in the interbank market.

The persistent deterioration of funding conditions in the interbank market causes that of all other segments of the financial system and, therefore, determines the terms of the monetary policy. If funding conditions in the interbank market are very deteriorated, the Taylor-type equation setting the official interest rate gives a result which is inferior to the central bank lower bound. Thus the interest rate is set at this lower bound level. Now let us assume that the central bank wants the interbank market to be always in equilibrium, as in the model monetary policy rule. Any shock on credit portfolios defaults directly affects the ability of banks to get interbank credit, forcing the central bank to conduct the corresponding liquidity injection. Assets purchases are conducted under the dual condition that the official interest rate is at the lower bound and the excess funding demand is persistent. In the case of private sector securities, the corresponding amount positively depends on the correlation of funding conditions with those of the interbank market. Finally, in the case of government bonds, in addition to the magnitude of the output gap, the amount of assets purchases by the central bank depends on regulatory factors (structural component of government bonds demand), government choices (structural fiscal deficit, propensity to support economic activity), and private choices (sensitivity of the government bonds demand to fiscal deficit, causing a decline in demand; and sensitivity to financial strains in other segments of the financial system, causing an increase).

Concluding remarks

The contribution of this paper in terms of theoretical modeling is threefold. First, the operation of financial system is formalized in order to take into account the major recent transformations, namely, on the one hand, the growing importance of households credits, within banks and total outstanding credits; and on the second hand the appearent disintermediation process, resulting from credit portfolios held outside of the traditional banking system. Then, the model proposes a transmission sequence of a shock on households credit portfolios to the whole financing system via the interbank market. Finally, the central bank monetary policy captures decisions in both non-crises times, with the Taylor-type rule; and crises times, with the intervention thresholds associated with liquidity injections and assets purchases, and the corresponding restrictive conditions.

Two original conclusions emerge. First, with regards to the rule setting the official interest rate, consideration of households credits in the intermediation chain modifies the interpretation of the Taylor rule: a negative output gap, rising the default rate, generates financial strains. In these conditions, in the case of a financial system with large households credits, if the central bank highly weighs the output gap, the financial stability objective is *de facto* taken into account. On the contrary, in a financial system with a lower proportion of households credits, taking into account financial stability requires to use an augmented Taylor rule including a financial conditions indicator. Second, the characteristics of the financial system, and in particular how the interest rate risk is borne respectively by banks and borrowers, determine the extent and conditions of transmission of the initial shock, and therefore the terms of monetary policy. If this risk is borne in excessive proportion by borrowers, any positive interest rate shock can deteriorate funding conditions enough for the central bank to mobilize the full range of unconventional monetary policy instruments.

References

[1] Adrian, Tobias, and Hyun Song Shin. 2010. "The Changing Nature of Financial Intermediation and the Financial Crisis of 2007–2009." Annual Review of Economics 2 (1) (September 4): 603–618.

[2] Bastidon Gilles, Cécile, Nicolas Huchet, and Philippe Gilles. 2012. "Amplification Effects and Unconventional Monetary Policies." Theoretical and Applied Economics Vol. 19.2012, 2, p. 13-30.

[3] Beck, Thorsten, Berrak Buyukkarabacak, Felix Rioja, and Neven Valev. 2008. Who Gets The Credit? And Does It Matter? Household Vs. Firm Lending Across Countries. World Bank Publications.

[4] Benford, James, and Erlend Nier. 2007. "Monitoring Cyclicality of Basel II Capital Requirements." Bank of England Financial Stability Paper (3 - December 2007): 13.

[5] Bernanke, Ben, Vincent Reinhart, and Brian Sack. 2004. "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment." Brookings Papers on Economic Activity 2004 (2): 1–100.

[6] Bernanke, Ben S., and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission". Working Paper 5146. National Bureau of Economic Research.

[7] Berndt, Antje, and Anurag Gupta. 2009. "Moral Hazard and Adverse Selection in the Originate-to-distribute Model of Bank Credit." Journal of Monetary Economics 56 (5) (July): 725–743.

[8] Boivin, Jean, and National Bureau of Economic. 2010. How Has the Monetary Transmission Mechanism Evolved Over Time? NBER Working Paper Series no. w15879. Cambridge, Mass: National Bureau of Economic Research.

[9] Bordes, Christian, and Laurent Clerc. 2010. "The ECB art of central banking and the separation principle." Banque de France Working Paper (290) (August): 39 p.

[10] Borio, Claudio E. V., and Haibin Zhu. 2008. "Capital Regulation, Risk-Taking and Monetary Policy: A Missing Link in the Transmission Mechanism?" BIS Working Papers (268) (December): 45 p.

[11] Boutillier, Michel, and Jean-Charles Bricongne. 2012. "Disintermediation or Financial Diversification? The Case of Developed Countries." Document de Travail Banque de France (380) (April): 31 p.

[12] Büyükkarabacak, Berrak, and Neven T. Valev. 2010. "The Role of Household and Business Credit in Banking Crises." Journal of Banking & Finance 34 (6) (June): 1247–1256.

[13] Cardarelli, Roberto, Selim Elekdag, and Subir Lall. 2011. "Financial Stress and Economic Contractions." Journal of Financial Stability 7 (2) (June): 78–97.

[14] Carré, Emmanuel. 2011. "'DSGE', L'art Des Banques Centrales Au Défi de La Crise Financière." Economie Appliquée : Archives de l'Institut de Sciences Mathématiques et Economiques Appliquées ; an International Journal of Economic Analysis. - Paris : ISMEA, Vol. 64.2011, 4, p. 171-189.

[15] Caruana, Jaime, and Laura Kodres. 2008. "Liquidity in Global Markets." Financial Stability Review – Special Issue on Liquidity (11) (February): 65–74.

[16] Castro, Vítor. 2011. "Can Central Banks' Monetary Policy Be Described by a Linear (augmented) Taylor Rule or by a Nonlinear Rule?" Journal of Financial Stability 7 (4) (December): 228–246.

[17] Chadha, Jagjit S., Lucio Sarno, and Giorgio Valente. 2004. "Monetary Policy Rules, Asset Prices and Exchange Rates". CDMA Working Paper Series 0403. Centre for Dynamic Macroeconomic Analysis.

[18] Cornett, Marcia Millon, Jamie John McNutt, Philip E. Strahan, and Hassan Tehranian. 2011. "Liquidity Risk Management and Credit Supply in the Financial Crisis." Journal of Financial Economics 101 (2) (August): 297–312.

[19] Cukierman, Alex. 2013. "Monetary Policy and Institutions before, During, and after the Global Financial Crisis." Journal of Financial Stability.

[20] Cukierman, Alex, and Anton Muscatelli. 2008. "Nonlinear Taylor Rules and Asymmetric Preferences in Central Banking: Evidence from the United Kingdom and the United States." The B.E. Journal of Macroeconomics 8 (1) (January 25).

[21] Curdia, Vasco, and Michael Woodford. 2009. "Conventional and Unconventional Monetary Policy". SSRN Scholarly Paper ID 1507510. Rochester, NY: Social Science Research Network.

[22] Cúrdia, Vasco, and Michael Woodford. 2010. "Credit Spreads and Monetary Policy." Journal of Money, Credit and Banking 42: 3–35. Daglish, Toby. 2009. "What Motivates a Subprime Borrower to Default?" Journal of Banking & Finance 33 (4) (April): 681–693.

[23] ECB. 2012. "EU Structural Financial Indicators". ECB. http://www.ecb.int/stats/pdf/121030 _ssi_table.pdf?19069a699ddcd6c603aabf84392808d6.

[24] Freixas, Xavier, and José Jorge. 2008. "The Role of Interbank Markets in Monetary Policy: A Model with Rationing." Journal of Money, Credit and Banking 40 (6): 1151–1176.

[25] Gambacorta, Leonardo. 2009. "Monetary Policy and the Risk-Taking Channel". SSRN Scholarly Paper ID 1519795. Rochester, NY: Social Science Research Network.

[26] Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti. 2010. "Credit and Banking in a DSGE Model of the Euro Area." Journal of Money, Credit and Banking 42 (August 18): 107–141.

[27] Gertler, Mark, and Peter Karadi. 2011. “A Model of Unconventional Monetary Policy.” Journal of Monetary Economics 58 (1) (January): 17–34.

[28] Goodhart, C.A.E. 2006. “The ECB and the Conduct of Monetary Policy: Goodhart’s Law and Lessons from the Euro Area.” JCMS: Journal of Common Market Studies 44 (4) (November): 757–778.

[29] Goodhart, Charles. 2009. “Whatever Became of the Monetary Aggregates?” In Monetary Policy Frameworks for Emerging Markets, edited by Gil Hammond, S.M. Ravi, and Eswar Prasad, 59–68. Edward Elgar Publishing.

[30] Helbling, Thomas, Raju Huidrom, M. Ayhan Kose, and Christopher Otrok. 2011. “Do Credit Shocks Matter? A Global Perspective.” European Economic Review 55 (3) (April): 340–353.

[31] Hoffmann, Andreas. 2013. “Did the Fed and ECB React Asymmetrically with Respect to Asset Market Developments?” Journal of Policy Modeling 35 (2) (March): 197–211.

[32] Hristov, Nikolay, Oliver Hülsewig, and Timo Wollmershäuser. 2012. “Loan Supply Shocks During the Financial Crisis: Evidence for the Euro Area.” Journal of International Money and Finance 31 (3) (April): 569–592.

[33] Ireland, Peter N. 2004. “Money’s Role in the Monetary Business Cycle.” Journal of Money, Credit, and Banking 36 (6): 969–983.

[34] Krishnamurthy, Arvind. 2010. “How Debt Markets Have Malfunctioned in the Crisis.” Journal of Economic Perspectives 24 (1) (February): 3–28.

[35] Maddaloni, A., and J.-L. Peydro. 2011. “Bank Risk-taking, Securitization, Supervision, and Low Interest Rates: Evidence from the Euro-area and the U.S. Lending Standards.” Review of Financial Studies 24 (6) (May 18): 2121–2165.

[36] Mishkin, Frederic S. 1996. “The Channels of Monetary Transmission: Lessons for Monetary Policy”. Working Paper 5464. National Bureau of Economic Research.

[37] Purnanandam, A. 2010. “Originate-to-distribute Model and the Subprime Mortgage Crisis.” Review of Financial Studies 24 (6) (October 14): 1881–1915.

[38] Stein, J. C. 2012. “Monetary Policy as Financial Stability Regulation.” The Quarterly Journal of Economics 127 (1) (January 6): 57–95.

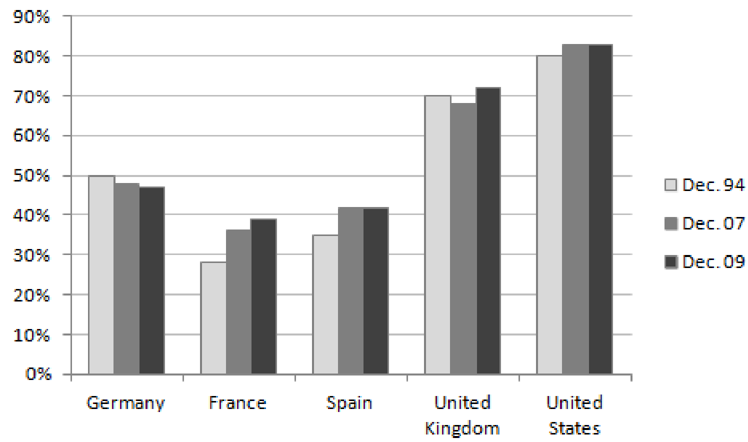
[39] Sturm, Jan-Egbert, and Jakob De Haan. 2010. “Does Central Bank Communication Really Lead to Better Forecasts of Policy Decisions? New Evidence Based on a Taylor Rule Model for the ECB.” Review of World Economics 147 (1) (November 6): 41–58.

[40] Taylor, John B. 1993. “Discretion Versus Policy Rules in Practice.” Carnegie-Rochester Conference Series on Public Policy 39: 195–214.

[41] Williams, John C., and John B. Taylor. 2009. “A Black Swan in the Money Market.” American Economic Journal: Macroeconomics 1 (1): 58–83.

[42] Wu, Tao. 2008. “On the Effectiveness of the Federal Reserve’s New Liquidity Facilities”. SSRN Scholarly Paper ID 1136942. Rochester, NY: Social Science Research Network.

Appendix



The narrow interest measures the proportion of credits from domestic financial institutions, with respect to all financings of non-financial agents. The data used in this figure were taken from Boutillier & Bricongne (2012).

Figure 1: Proportion of households credits in the intermediation rates (narrow sense, in %)

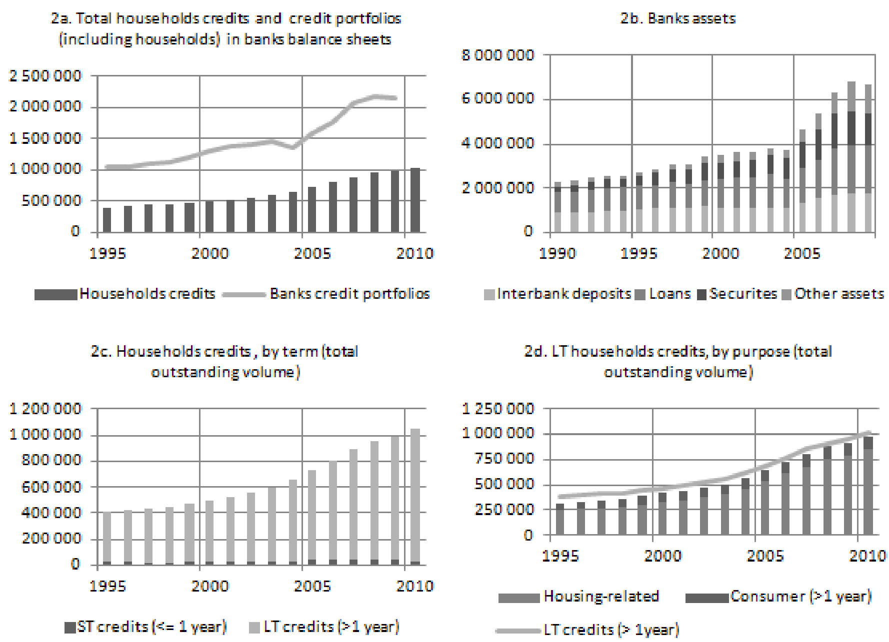


Figure 2: France: households credits and banking intermediation (millions EUR, OCDE data)

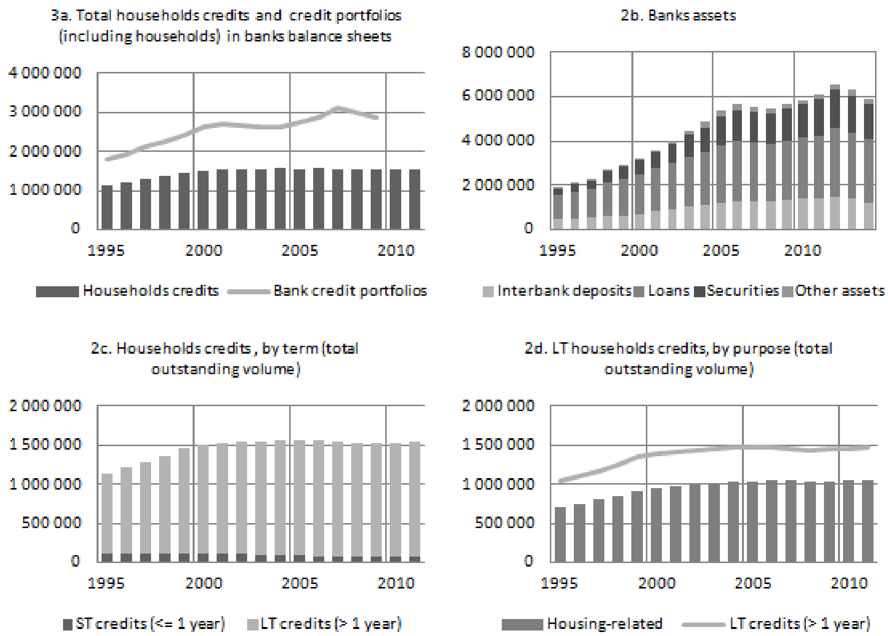


Figure 3: Germany: households credits and banking intermediation (millions EUR, OCDE data)

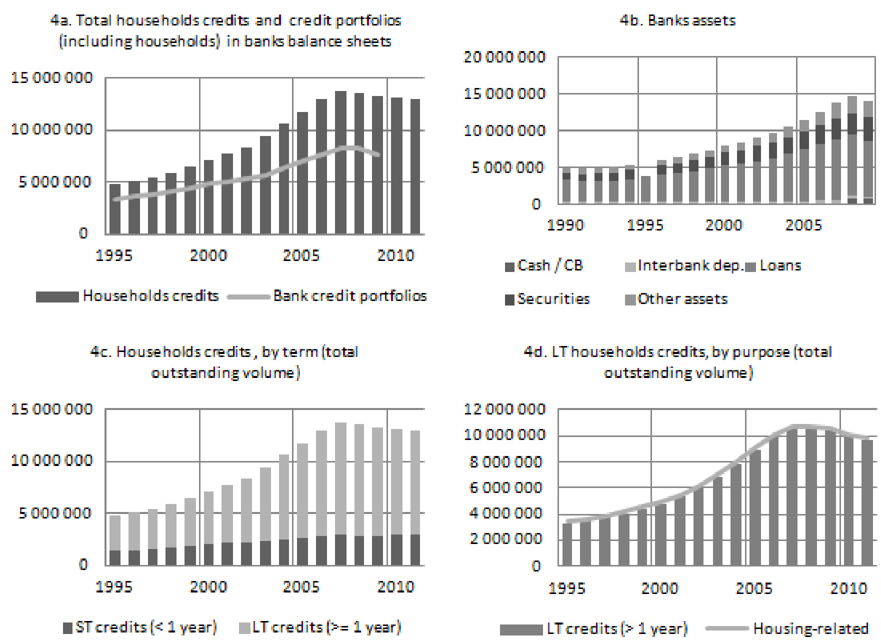


Figure 4: United States: households credits and banking intermediation (millions USD, OCDE data)

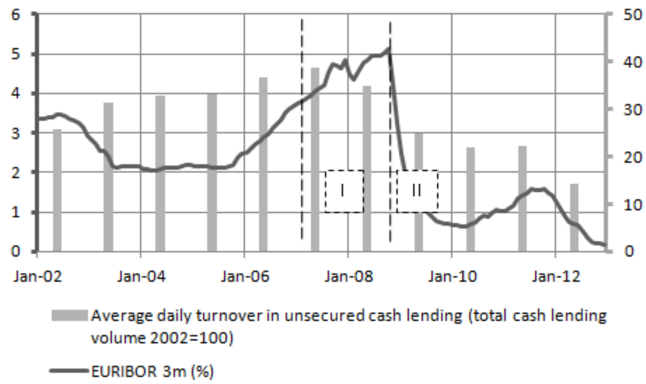


Figure 5: Interbank market, eurozone (ECB and EBF data)

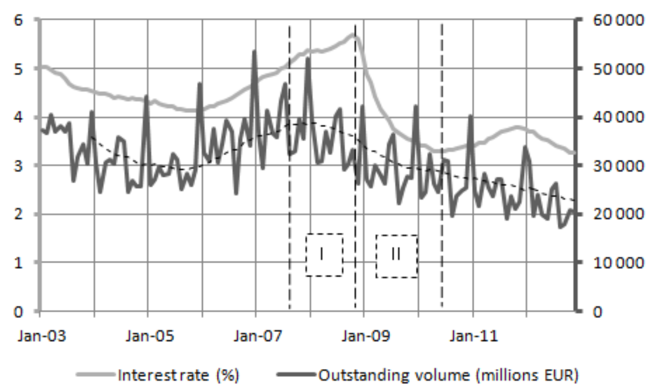


Figure 6: Credit markets, Eurozone: non financial corporations (ECB data)

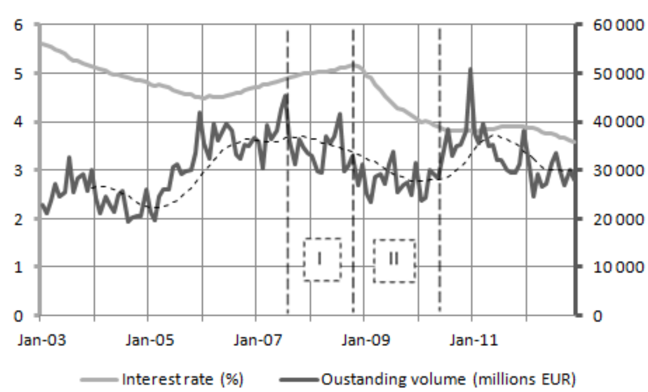


Figure 7: Credit markets, Eurozone: households (ECB data)

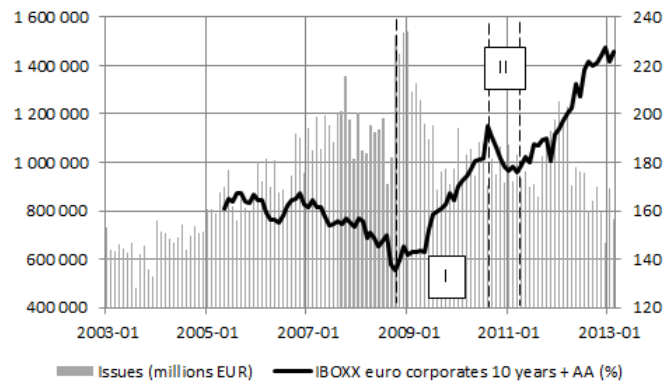


Figure 8: Debt securities markets, Eurozone (ECB data)

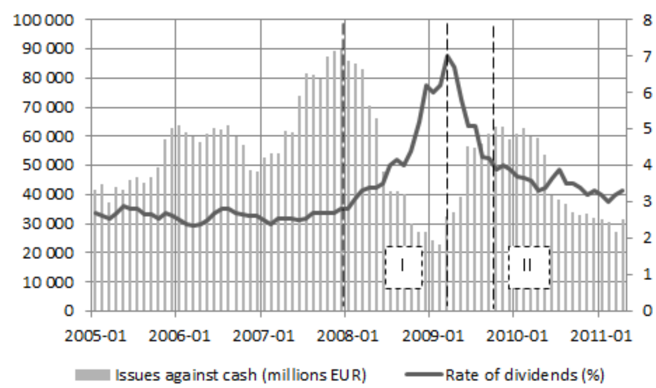
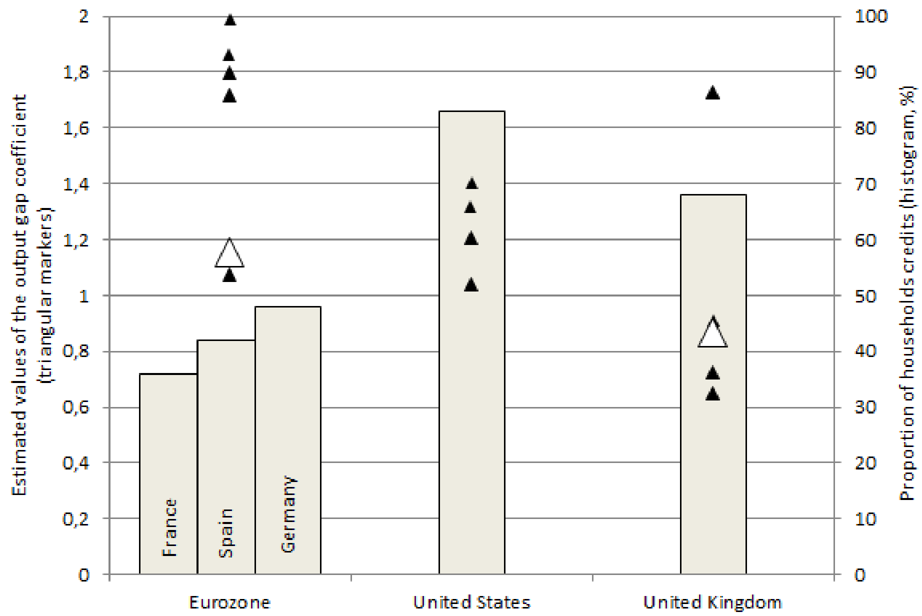


Figure 9: Equities markets, Eurone (ECB and Datastream data)



Reading: the estimations with the simple Taylor rule are represented with black triangular markers. The estimation with the augmented Taylor rule, when it is significant, is represented with a white marker. The monetary policy rules followed by the ECB and BOE are best described by an augmented Taylor rule, respectively including a financial conditions indicator, and the credit spread. By contrast, the tests indicate that the FED is following a simple Taylor rule. The data used in this figure were taken from Boutillier & Bricongne (2012) for intermediation rates (in 2007), and Castro (2011) for the Taylor rule estimations (corresponding to 1999-2007 for the ECB, 1992-2007 for the BOE and 1982-2007 for the FED).

Figure 10: Estimation of the output gap weight in the Taylor rule (triangular markers, left axis) and proportion of households credits in the intermediation rates (histogram, right axis)